



Workshop Report: Towards Nearly Zero Energy Buildings – Definition of common principles under EPBD

Monday 24 September, 10:00-17:00

Venue: Centre Albert Borschette (CCAB), room 4C, rue Froissart 36 – 1040 Bruxelles.

Organised by: eceee on behalf of the European Commission and the consortium (Ecofys, Politecnico di Milano and the University of Wuppertal, with various national subcontractors), contracted by the European Commission to define common principles for nearly-zero energy building under the EPBD.

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1. Morning session: Overview of project

1.1 Welcome

Nils Borg introduced the eceee and the panel members, namely:

- Andreas Hermelink (Ecofys)
- Thomas Boermans (Ecofys)
- Lorenzo Pagliano (Politecnico di Milano)
- Eike Musall (University of Wuppertal)
- Robert Nuij (Energy Efficiency, European Commission DG Energy)
- Paul Hodson (Head of Unit, Energy Efficiency, European Commission DG Energy)

He introduced the directive and explained that the intent of this current project, and this workshop, is to create usable tools to help Member States implement the directive. He asked participants to offer constructive input rather than lengthy position statements. In particular, he pointed out that this workshop is not specifically about cost-optimality for which regulation already exists, but that it will be addressed in relation to the nZEB definition.

1.2 Introduction: (Paul Hodson, DG Energy)

Paul Hodson spoke about how energy efficient buildings are critical to achieve a whole range of DG Energy's objectives. In particular, he spoke of three priorities, including:

1. When buildings are refurbished, it must be done to a high level. Policies that encourage this include the provisions within the Energy Performance of Buildings Directive (EPBD), Eco-Design plus the new Energy Efficiency Directive.
2. New build must achieve very high levels of performance as it is with new build that the greatest levels of energy efficiency can be most easily achieved. Policies that promote this include the Nearly Zero Energy Buildings (nZEB) obligations within the EPBD.
3. The rate of refurbishments must be increased. Provisions for this are included in Articles 4 and 5 of the EED.

The dates and the directive were outlined and the bottom-up nature of developing European buildings energy efficiency policy was described. The role of this project was explained to firstly provide Member States with tools which will help implement this important area of policy, secondly to enable the Commission to engage and advise Member States to ensure a minimum level of consistency across the legislation in the different Member States and finally, to inform the relationship between the nZEB and cost-optimality.

1.3 Project overview and interim findings

1.3.1 Project overview (Andreas Hermelink, Ecofys)

The project is structured into four tasks:

- Task 1: Existing definitions for nZEB – led by Eike Musall, University of Wuppertal;
- Task 2: National plans for increasing the number of nZEB - led by Andreas Hermelink, Ecofys;
- Task 3: Benchmarks for nZEB - led by Lorenzo Pagliano, Politecnico di Milano; and
- Task 4: Link between nZEB and cost-optimality - led by Thomas Boermans, Ecofys.

The first three of which are well underway but the fourth is at an initial stage. The timetable of the project was presented (see Gantt Chart in presentation) and it was explained that after this workshop, there will be further work on all the tasks to take into account the feedback from the day and that further feedback after the workshop could be emailed directly to Ecofys to: nzeb@ecofys.com .



1.3.2 Interim findings: Task 1 – Existing definitions for nZEB in Member States (Eike Musall, University of Wuppertal)

The first step of this task was to identify the elements of the definition of nZEB that are already stipulated within the EPBD.

The review then identified more than 70 existing definitions of nZEBs from 18 countries and a number of international non-governmental and scientific organisations, many of which were identified in the IEA research project “Towards Net Zero Energy Solar Buildings” (see <http://www.iea-shc.org/task40/>).

The methodologies were compared against different assessment categories, a number of which came from the requirements of the EPBD, and were placed into an Excel spreadsheet which facilitated the identification of differences and similarities between the numerous methodologies. The assessment categories included, for example:

- Accounting system metric (whether the performance of the building is measured in terms of delivered energy, primary energy, carbon dioxide emissions etc...)
- Balance boundary for end uses included and renewable energy generation (whether the definition includes space heating, cooling, domestic hot water, lighting, auxiliary energy, plug loads, embodied energy etc. and different on-site or off-site generation options...)
- Normalisation (whether the energy performance is normalised with respect to Net Floor Area, Gross Floor Area etc...).

A database of more than 300 nZEBs (all building types) from around the world, which was also developed in the above mentioned IEA program, could also be used as a source. A smaller number were assessed in more detail to identify how they achieved their nZEB performance. Information on monitoring of nZEBs was also collated where available.

The final output of Task 1 was to create a template that Member States can use to report to the Commission on how they intend to define nZEBs. The template was created using the comparative taxonomy developed through the analysis of the different existing methodologies and contains guidance on how it should be filled in. This spreadsheet has already undergone provisional testing. Feedback from this review as to wording and functionality has been incorporated in the current draft.

1.3.3 Interim findings: Task 2 – National Plans for increasing the number of nearly zero-energy (or beyond) buildings (Andreas Hermelink, Ecofys)

The main sources of information on how Member States are preparing to increase the number of nZEBs were identified. They included the information included within the National Energy Efficiency Action Plans (NEEAPs), the National Renewable Energy Action Plans (NREAPs), the body of research produced by Concerted Action on how Member States are implementing the EPBD and working towards nZEB performance and also the BuildUp website portal. In addition, a number of experts were contacted directly as part of this project as to what would be included in a national implementation plan.

The requirements of the NEEAPs and NREAPS were compared to the requirements of the EPBD (which include the detailed definition of nZEB, intermediate 2015 targets, policies and financial measures that ensure that the 2018 and 2020 nZEB targets will be met and that stimulate the refurbishment of existing buildings to nZEB standards). It was found that there were several areas of overlap, including the reporting of national targets for nZEBs in the NEEAPs and the reporting of the minimum levels of the use of renewable energy in buildings in the NREAPs. However, in many cases, the reporting requirements were not as in-depth as those required for the EPBD.

The submitted NEEAPs and NREAPS from 12 Member States across Europe were then reviewed to identify which items had actually been reported as specifically required by the EPBD. Key findings included:



- Since the template for the NEEAPs became available in the second reporting round, the quality or the reporting was greatly improved. However, as many MSs had produced their own template for the first reporting round, they continued to use it for the second. Thus it was recommended that a template be produced at as early a stage as possible.
- ‘Conflict categories’ were identified, which are those that were largely absent from the existing reporting requirements, in particular the detailed definition of nZEBs and the intermediate 2015 targets. There was also little direct reference to moving towards nZEB standards for refurbishment.
- The structure and level of detail provided by different Member States was found to be variable. This is an issue for Member States who wish to learn from other Member States, as well as for the Commission, who are tasked with reporting progress across Europe.

From this analysis, it is expected that a number of MSs will have difficulty meeting the reporting requirements of the EPBD at the end of this year. It is therefore very important to produce a template as early as possible that covers the EPBD requirements, identifying the appropriate level of detail required and showing the synergies between reporting on NEEAPs, NREAPS and cost-optimality rather than requiring a duplication of work.

1.3.4 Interim findings: Task 3 – Benchmarks for Nearly Zero Energy Buildings (Lorenzo Pagliano, Politecnico di Milano)

This task involved assessing the technological and economic feasibility of achieving nZEBs in new build and refurbishments in four locations across Europe for three building types (a single family house, an apartment block and an office building).

The feasibility of achieving nZEB performance was assessed by comparing the global lifecycle costs with net primary energy consumption for numerous building fabric and plant specifications (>10,000 appropriate for each location) and from private as well as societal perspectives.

- The global lifecycle costs include the capital, replacement, disposal and operational costs for the lifetime of the building (defined for this study as 30 years) using a number of discount rates representing private and societal perspectives, in line with the EPBD cost-optimal methodology.
- The net primary energy consumption is defined as the unconverted fossil fuel energy requirements. This was calculated by firstly modelling the energy (fuel and power) consumption of the building for heating, cooling, domestic hot water, lighting and auxiliary energy, using established methodologies along with a number of assumptions (for example, the levels of internal gains). The energy consumption was then converted to primary energy and the energy generated on site from renewable sources taken away from this figure to give the net primary energy consumption of the building.
- Further information on common terms, definitions and on-going developments can be found on the [buildup.eu](http://www.buildup.eu) website. A list of all the EN standards involved in energy and comfort assessment of buildings and in particular nZEBs as well as a summary of the “Umbrella Document” is given in: <http://www.iec-cense.eu/>

Graphs of global lifecycle costs against net primary energy were then used to define a nZEB ‘space’, or range of feasible nZEB benchmarks, for each location and set of boundary conditions and discount rates.

This method has been developed in order to be able to define nZEBs and discuss the level of performance that is feasible in different climates. However, all parameters and aspects of the modelling methodology are open for discussion and criticism. It is the methodology as well as the inputs and assumptions used in this study rather than the absolute results which should be seen to be of greatest interest. Inputs and assumptions identified as particularly interesting for discussion/review included (amongst others):

- Weather data: whether it is appropriate to use weather data from the outskirts of a city when the effects of the Urban Heat Island may be significant and whether future climate



projections should be taken into account. Access to weather data may be an issue for some Member States as well as access and accuracy of climate projections.

- Internal conditions: whether raised air velocities should be permitted as a way of achieving thermal comfort, and if so, how this should be modelled.
- Levels of internal gains: whether future changes in the energy consumption of products, and therefore their contribution to internal gains should be considered in the modelling.

Moving forward, this should be a common/collaborative undertaking. Feedback and comments are encouraged on all aspects of this work.

Questions and discussion:

- In response to queries from workshop participants, the panel confirmed the following methodological issues:
- The methodology used in this study is not new; it is compatible with CEN standards and therefore in principle not in contradiction with national calculation methodologies.
- It was explained that the choice to undertake this modelling using dynamic building energy simulation was to ensure that summertime overheating issues were adequately modelled as these issues are considered to be of increasing importance in the future.
- The modelling covered both new build and refurbishment because the EPBD not only requires new build to achieve nZEB performance by 2021, but includes requirements for Member States to show how the retrofitting of existing buildings to nZEB standards is being encouraged. Modelling the feasibility of achieving nZEB standards in both new and existing buildings was therefore part of the call for tender for this work.
- The modelling undertaken in this study did not include the energy consumption from appliances, except in terms of the contribution to internal heat loads. Whilst it was acknowledged that a number of the voluntary standards/definitions on nZEB that were reviewed as part of Task 1 of this study did include appliance energy use, the majority of official definitions of nZEB in Member States did not. Therefore, for this modelling to be of most relevance to Member States, this end use was not included. One participant added to this discussion by saying that appliance energy use is extremely variable and therefore notoriously difficult to model.

Finally, a general comment was made regarding the fact that the modelled performances of materials are sometimes theoretical and that this may result in gaps between the modelled and in-use performance of buildings. It was suggested that this would be the next important issue to be tackled.

1.3.5 Interim findings: Task 4 – The link and consistency between nZEBs and cost-optimality (Thomas Boermans, Ecofys)

This presentation summarised the requirements in the EPBD and explained how there could be a perceived conflict between the requirements of cost-optimality and the requirement for nZEBs. The purpose of this part of the project is to investigate links and consistency issues between these requirements and establish whether nZEBs are or could be cost-optimal in the future by identifying potential technological or cost gaps.

Article 4 of the EPBD states that minimum energy performance standards should be shaped with a view to be cost-optimal, Article 5 then elaborates on how cost-optimality should be established and then Article 9 introduces the nZEB requirements from 2021.

It initially appears that these two goals may be quite different. Is there a conflict? Can nZEBs be cost-optimal? If so, how far away are we from this goal (what are the technological and costs gaps)? These are the questions that this part of the study intends to answer. The project consortium's interpretation is that when the EPBD was negotiated, it was considered that these definitions would converge by 2021.

One clause within Article 9 however does raise some questions. The clause states that Member States might choose not to apply the nZEB requirements when a cost-benefit analysis over the economic lifecycle of the building is negative. This reference to cost-benefit analysis rather



than to global costing or cost-optimality could point to a current lack of consistency between the requirements.

Questions and discussion:

One participant initiated a discussion regarding the ‘specific and justifiable cases’ which might not be required to meet the nZEB standards. A representative from the Commission explained that this paragraph does give Member States scope to exclude certain building types. However, the Commission does not anticipate this article being used as a way of excluding entire building categories.

2. Afternoon session: Feedback and discussion

The purpose of the afternoon session was to gather input from all stakeholders on the draft study findings and suggestions. The focus was on the tasks that elaborate support for the Member States in meeting the EPBD requirements.

2.1 Draft reporting template for national plans – overview (Andreas Hermelink)

The reporting requirements of the EPBD were reiterated, as well as the relationship between these requirements and those of the NEEAPs. Templates have been shown to aid Member States in meeting such requirements. The draft reporting template created in the project is purposefully not too elaborate as its development should be guided by feedback received during this workshop and also following it. Comments are welcome at nzeb@ecofys.com.

Questions and discussion:

Project members posed questions to the workshop participants regarding the appropriateness and usefulness of asking Member States to include a summary of the energy performance of their country’s building stock and a chronological development of energy efficiency building regulations, within their national plans. Key points made were:

- Not all Member States have the information on their building stock easily available, especially for non-domestic buildings. Therefore this might be a large burden if it were a mandatory requirement.
- This would be an interesting and useful addition to the EPBD reporting requirements, especially if Member States created a roadmap that extended past 2030 and included policies that accompanied it. However, without the accompanying policies and improved compliance, it would not be a meaningful exercise.

It was also raised by one participant that nZEB performance is not a technical standard therefore its definition should evolve and eventually converge across Europe at a later date.

2.2 Draft reporting template for the definition of nZEB (Eike Musall)

The proposed reporting template was created using the comparative taxonomy for nZEB developed in this study, as presented in the morning session. One way of understanding nZEBs is in terms of the balance between energy demand and energy generation. There are a number of methodological items that need to be defined in order to undertake this balance calculation; including the metric, the accounting system and the balance period (amongst others). The aim of the template is to allow the Member States to define each of these methodological items in a straightforward and comparable way. Feedback recorded during the testing of the tool is included in the final slides of the presentation.

Each of the fields of the Excel-based template were described in turn, and the following points were highlighted regarding the structure and style of the spreadsheet, and a worked example using Danish data was used to illustrate its use:

- Each request for information contains a reference to the appropriate EPBD clause.
- Where possible drop-down boxes are included which contain the most likely options under each category to speed up the process of filling in the template and to make the content as



comparable as possible during the analysis by the European Union. However, you can also select 'other' and fill in as appropriate.

- Comments, or help items, are also included where possible.

Questions and discussion:

It was confirmed that the use of the reporting template being developed within this study is voluntary; the EPBD does not prescribe the format by which Member States need to report. It was also acknowledged that the timing of this project is not ideal and that the results of this project will not be of great use in this reporting round for Member States that have already spent time on preparing their national plans.

A number of queries as to the meaning of specific fields and the functionality of the spreadsheet were raised by workshop participants. In particular:

- The meaning of the field 'balance-type'. Workshop participants were unclear as to whether this should refer to the time period over which the balance of consumption and generation should be made, or the scope of the calculations (i.e. whether or not, for example, embodied energy is included), or something else entirely. It was also noted that in the referring to 'load vs. generation' might be misleading, as the work 'load' is usually associated with capacity.
- It was requested that the fields that are mandatory EPBD reporting requirements are differentiated from the 'nice to know' sections (perhaps by colour coding).
- It was noted that Member States may wish to have different requirements/definitions for refurbishments as opposed to new build. They may also have different requirements/definitions for different building types. The template may therefore need to have the functionality to allow more than one definition to be described within it.
- It was suggested that fields be included in the final template where Member States could stipulate the primary energy and/or thermal energy target e.g. 120kWh/m²/yr.
- It was also suggested that a fields for a name (e.g. Passive-House-Plus) and qualitative description be included.

The panel agreed to take all these issues on board and provide further guidance in the final version of the template.

It was reiterated by the panel that it is not the aim of this template to guide or limit the definitions being proposed by different Member States; rather the template should be flexible enough to Member States to easily explain what they are proposing to do.

2.3 Draft reporting template for national plans – for items other than the definition of nZEB (Andreas Hermelink)

The EPBD reporting requirements, other than the nZEB definition, were reiterated. In particular the interim targets for 2015, the requirement to identify the leading role of public sector buildings, and the requirement to state all policies and measures which are being proposed to encourage nZEBs, increases in renewable energy share and increases in energy performance in a cost effective way.

It was explained that a template for reporting on these issues has not yet been produced in Word or Excel as it was the intention to get feedback in this workshop and beyond on the most useful format and most useful content. Proposed content, which covers the mandatory requirements of the EPBD, was presented in slides 17-22 of the presentation. A section in the template on self-evaluation was suggested as a potential additional reporting requirement as it might be useful in explaining the progress to 2020 targets.

Questions and discussion:

The format of such a reporting template was discussed. It was concluded that whichever format was chosen, (whether it be Word, Excel or on-line) it should be printable so that it can be approved via normal political procedures. It was also confirmed, that as with the nZEB



definition template, it would be made clear which of the reporting requirements were mandatory and which were 'nice to know'.

The relationship between the EPBD and NEEAP reporting requirements were discussed. A representative from the Commission reported that they are currently re-visiting the NEEAPs in the context of the EPBD and will be updating them accordingly, hopefully by the end of the year. It was confirmed that the outputs of this project would be coordinated with this process. The aim will be to streamline the reporting system: whereas at the moment Member States are requirements to report through several channels, it is hoped that this will be reduced to one or perhaps two.

2.4 Benchmarks for nZEB (Lorenzo Pagliano)

Emphasis was again placed on the fact that this work should be a common effort. It was stated that the aim of this study was to identify the critical inputs for this type of analysis and to develop a method for assessing nZEBs in a transparent way. Having presented the methodology of this work in the morning session, the afternoon's session focussed on the results of the study, in particular the results from two locations; Catania and Stockholm.

It was explained that the level of performance achievable varies greatly depending on the climate. In Catania, nZEB performance was achievable and with similar global costs to buildings constructed to current standards. In Stockholm, however, it was not possible to achieve zero primary energy consumption with the assumptions made. But over the modelled 30 year lifecycle, even using discount rates for the private perspective, high levels of performance were found to be cost-effective.

It was pointed out that not every technology or strategy that is currently available was modelled. Had they been, it might have been possible to achieve higher levels of performance than those modelled in this study. For example (amongst others):

- Day-lighting strategies and task lighting could be used to reduce lighting energy consumption.
- The building's micro climate could be manipulated using green spaces and cool surfaces.
- Conditioning to a wider range of internal temperatures and allowing higher air speeds in summer could be used as a strategy to reduce demands for heating and cooling.

Questions and discussion:

Further details regarding the calculation methodology were discussed and clarified, including:

- The primary energy factors used in the modelling were those current in Italy at the time of the modelling. The same factors were used across the lifecycle of the building and in all modelled locations. This was because the study was primarily interested in the effect of climate on achieving nZEB performance standards.
- The study focused on three building types only. This was due to the limit of the scope of the project. The objective of this project was to develop a methodology and investigate how inputs and constraints affect the results, rather than model all building typologies for all Member States. It is the hope that Member States come up with their own solutions and will do their own modelling.
- It was confirmed that domestic hot water is included in the modelling.
- The absolute costs have been calculated assuming certain fixed costs, for example for the structure of the building, which was relatively arbitrary. To that base number, the additional costs of efficiency measures and renewable energy technologies were added. Therefore it is the relative costs rather than the absolute costs that are of most interest.
- The most obviously unrealistic building specification combinations were not modelled. However, there are still modelled combinations that might not be common or likely (for example, high cost and high consumption) and hence not all modelled combinations might be on the market. The most useful information in these graphs will be the relative position of points in the lower boundary.



- The modelling has been undertaken with today's primary energy factors, which will most likely reduce and only the technologies that are available today. Thus it can be thought of as somewhat conservative.
- As only commonly available technologies have been modelled, no additional costs were included in the modelling for training the workforce. A participant suggested that if novel technologies were included in future modelling, training costs should also be considered.

One participant raised the issue of the gap between the modelled theoretical and in-use performance of even common technologies. For example, high levels of air tightness are rarely met in reality and poor maintenance of many systems result in reduced performance. It was suggested that this be taken into account in future modelling.

The usefulness of assessing the trends, or correlation coefficients, in the scatter plots of net primary energy against global costs was discussed. It was concluded that due to the differences between the specifications behind each point in the scatter plot, such a trend would not be that meaningful.

It was commented that one of the most interesting outcomes of this work was that increasing the discount rate from 6 to 10% did not result in a radical change to the shape of the graph and that a lot could be learned from this work in relation to cost-optimality.

The workshop and panel discussed the importance of early-stage and cross-discipline decision making as key to successful achievement of nZEB performance standards.

The panel concluded the session by emphasizing that this important work really does need to be a common and collaborative in nature. This current project has demonstrated one method for establishing the feasibility of nZEB performance standards which could be used by Member States in their own climatic conditions and for their building stock. However, one of the main aims of this study was to facilitate discussion and engagement around these issues. The workshop participants were again encouraged to interrogate all the assumptions used in this modelling and provide as much feedback as possible.

3 Summary and outlook

The final steps of the project were outlined, including the intention to release of the draft template and presentations for review following the workshop, the proposed deadline for feedback from participants, the further work intended to be undertaken by the panel and the estimated completion date of the project.

It was explained that the outputs of this project would be taken on board by the Commission when reviewing the NEEAP reporting requirements. A representative from the Commission explained that they will be producing a report on the submissions from each of the Member States by the end of the year and therefore encouraged all those involved in reporting their country's national plans, to submit what they can even if certain legislation is missing. The use of the templates developed in this project was encouraged.

Workshop members were thanked for their participation and encouraged to submit all comments and critiques of the work.

Contact the project: nzeb@ecofys.com